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[54] **COIL WINDING DEVICE HAVING A TURRET ROTATABLE BETWEEN A WINDING POSITION AND A TAPING POSITION**

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[51] **Int. Cl.**[5] **H01F 41/08**; H02K 15/09

[52] **U.S. Cl.** **242/7.08**

[58] **Field of Search** 242/7.03, 7.08, 7.23, 242/7.09; 156/446, 447

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,055,310	10/1977	Bonaiti	242/7.08
4,470,552	9/1984	Parham, Jr. et al.	242/7.03
4,722,486	2/1988	Camardella	242/7.03
4,809,917	3/1989	Tsuchiya .	
4,878,628	11/1989	Takeda et al.	242/7.08
4,951,889	8/1990	Camardella et al. .	

FOREIGN PATENT DOCUMENTS

3815998	12/1988	Fed. Rep. of Germany .
63-280404	11/1988	Japan .
2214533	9/1989	United Kingdom .

OTHER PUBLICATIONS

Patent Abstracts of Japan, vol. 14, No. 161 (E-909) 28 Mar. 1990 & JP-A-20 18 915 (Matsushita Electric) 23 Jan. 1990 (abstract).

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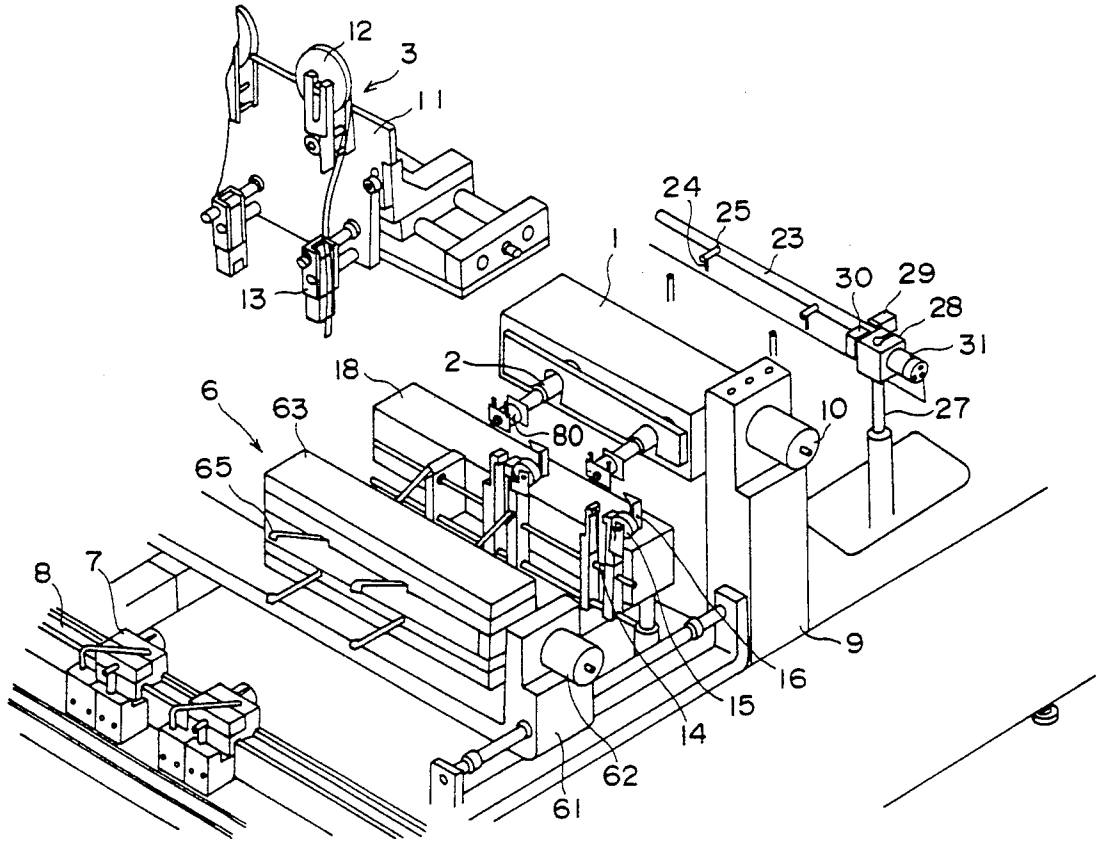
[57] **ABSTRACT**

A coil manufacturing device includes a turret having a spindle which turns a bobbin, a winding unit which winds wire on the rotating bobbin, and a taping unit which tapes the wire wound on the bobbin. A mechanism moves the spindle between the winding unit and the taping unit, and another mechanism changes over the wire supplied to the winding unit so that wire change-over and taping can be performed simultaneously. The winding unit includes a nozzle bar, a nozzle device provided on the nozzle bar for supplying the wire, a clamping device on the nozzle bar for holding an end of the wire and a nozzle displacement device for supporting the nozzle bar and moving it in three dimensions.

2 Claims, 6 Drawing Sheets



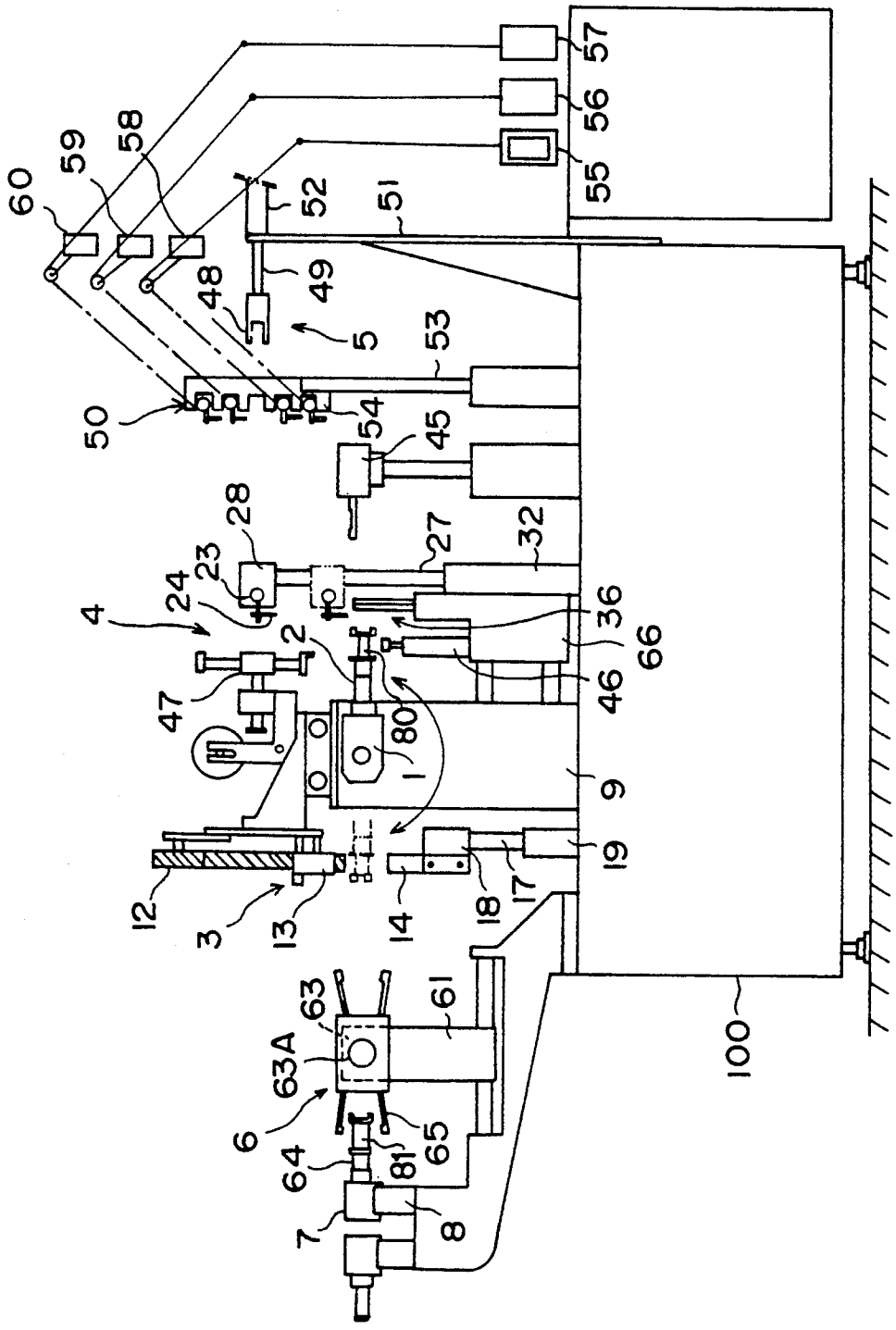

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FIG. 1

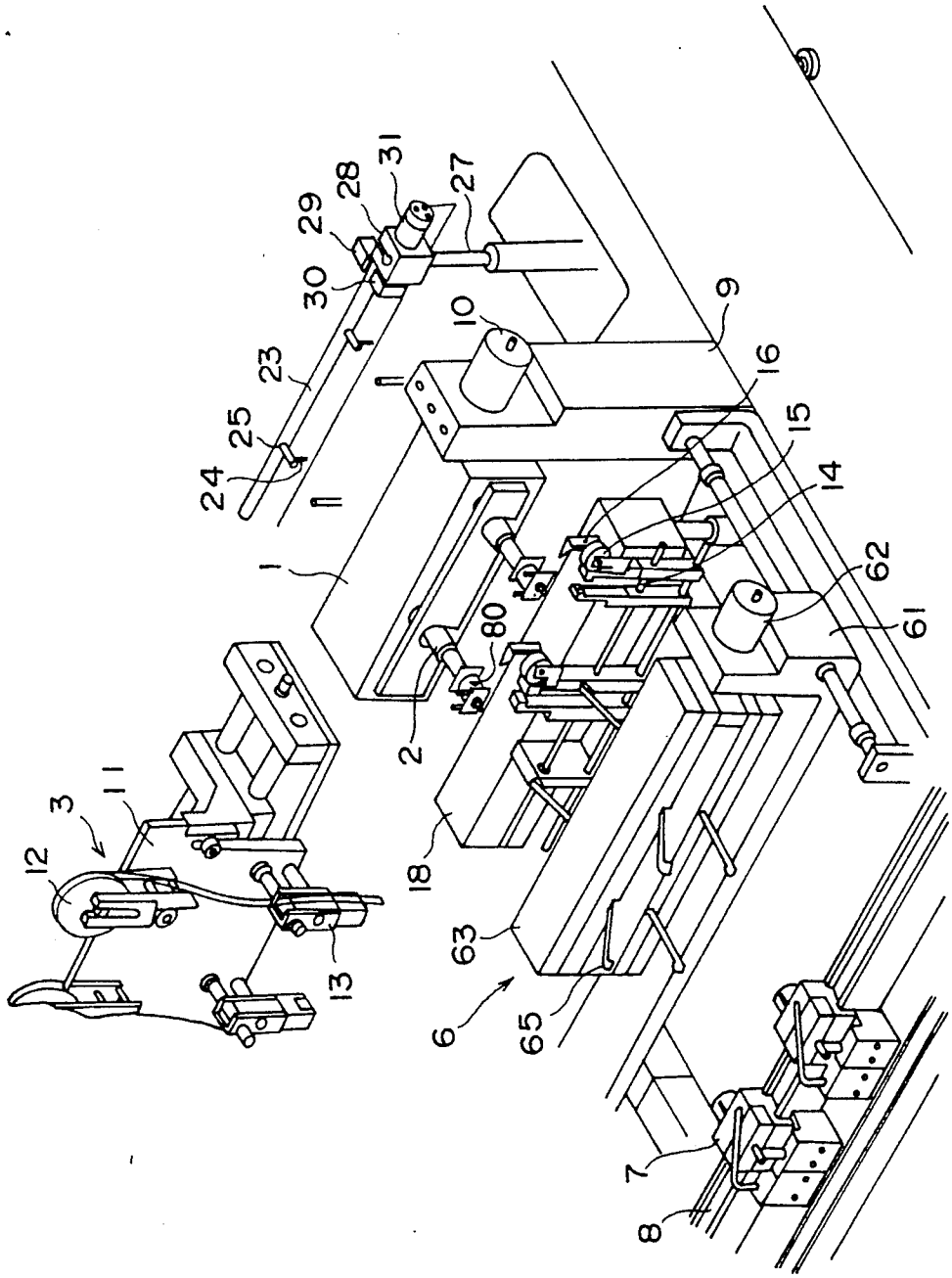

FIG. 2

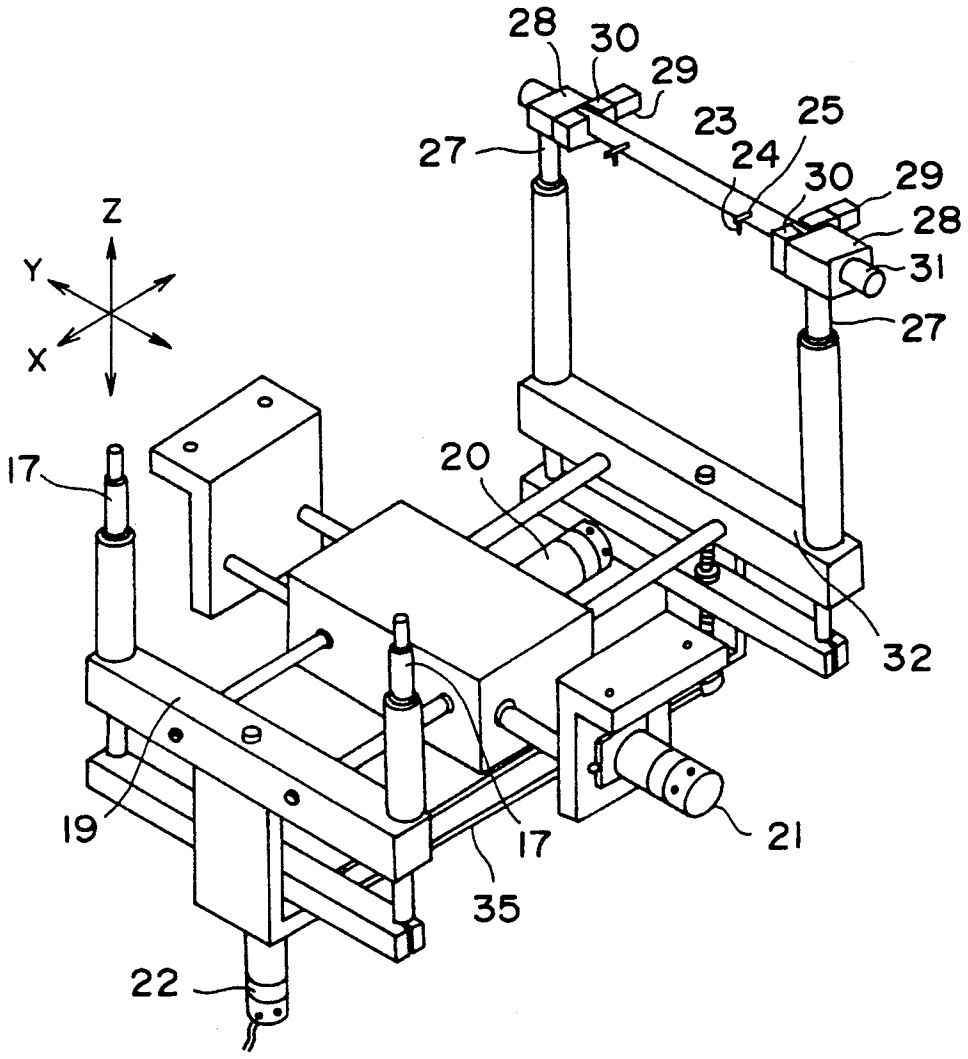

FIG. 3

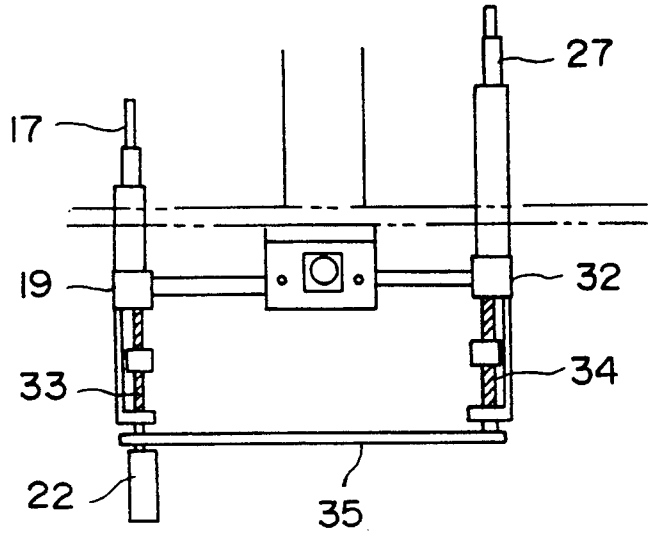

FIG. 4

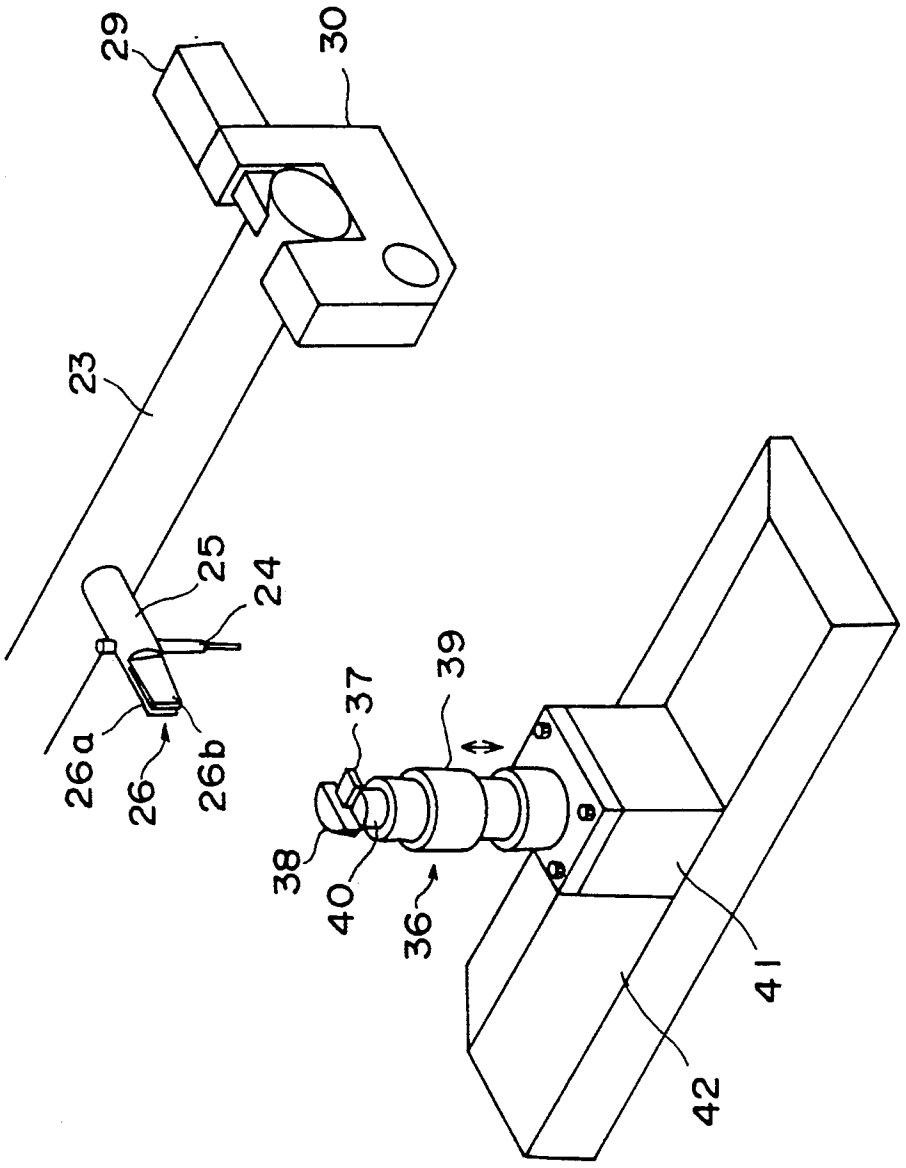

FIG. 5

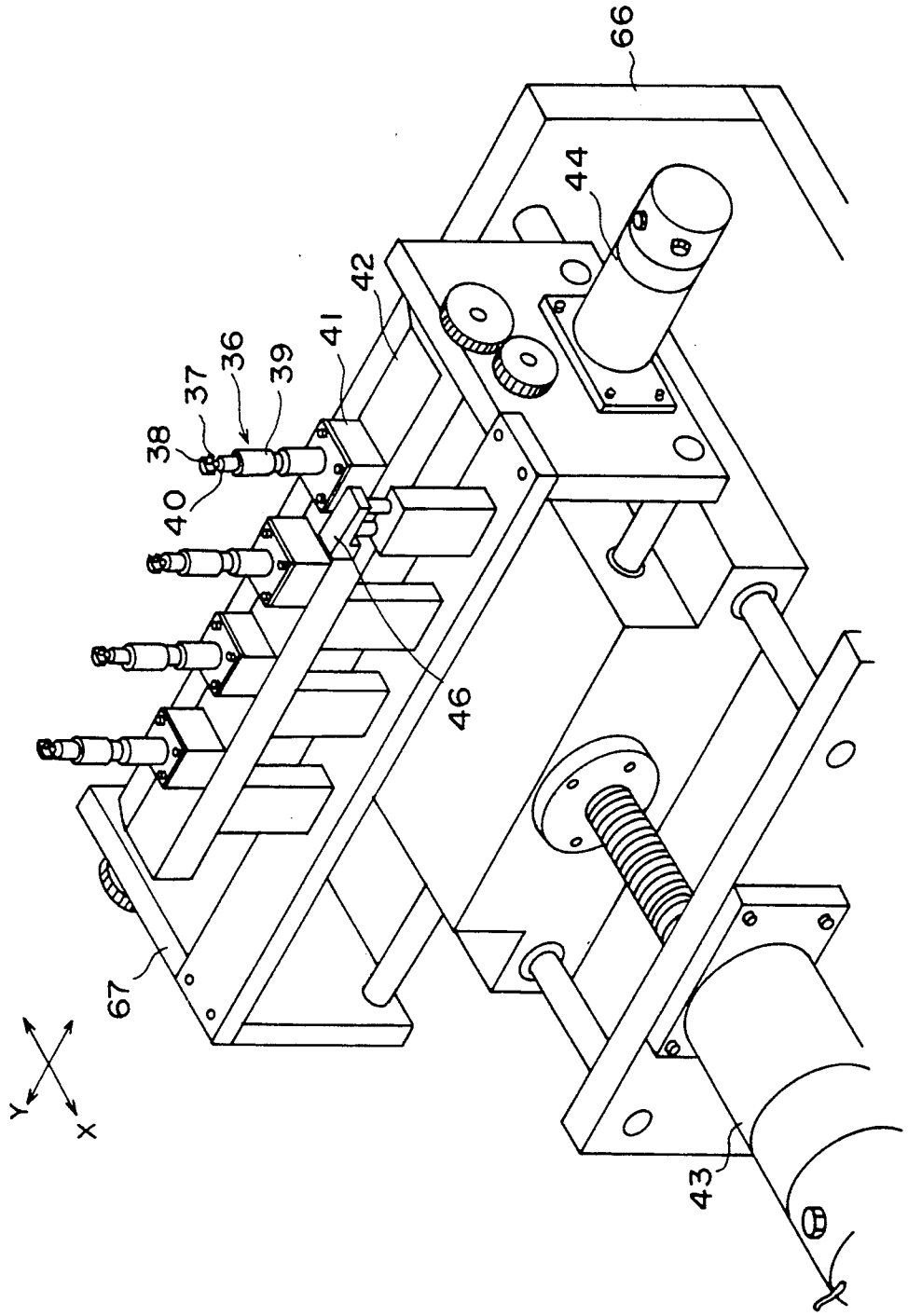

FIG. 6

COIL WINDING DEVICE HAVING A TURRET ROTATABLE BETWEEN A WINDING POSITION AND A TAPING POSITION

FIELD OF THE INVENTION

This invention relates to a coil winding device which winds and tapes a wire on a bobbin.

BACKGROUND OF THE INVENTION

Transformers are generally manufactured by winding and taping a wire alternately so as to build up a plurality of wire layers. A coil winding device wherein this operation is performed by a simple system is disclosed in Japanese Tokkai Sho 63-280404 published by the Japanese Patent Office.

This device comprises a nozzle holder and taping device supported by a supporting member such that they are free to move in three dimensions X, Y, Z. The winding operation is performed by rotating a bobbin supported on a spindle, supplying it with wire from a nozzle supported by the nozzle holder, and tying the wire by displacing the nozzle. Tape is then wound on the bobbin by activating a taping device.

If wires of different type or diameter are to be wound on the same bobbin, the wire has to be changed over. In this device, however, the winding position and taping position are the same, and the nozzle holder and taping mechanism are supported by the same supporting member. If it is attempted to install a separate wire change-over mechanism, therefore, the taping device is an obstruction.

Further, even if a wire change-over mechanism can be installed, the winding, taping and change-over of the wire are all performed at the same position. These operations can therefore be performed only sequentially, and the time required to perform the whole process is consequently longer.

SUMMARY OF THE INVENTION

It is therefore an object of this invention to perform wire change-over and taping operations without interfering with one another.

It is a further object of this invention to perform the whole coil winding process, including winding the wire on a bobbin, taping it and changing over the wire, efficiently in a short period of time.

In order to achieve the above objects, this invention provides a coil winding device comprising a turret having a spindle which is adapted to rotate a bobbin, a winding unit for winding a wire on the rotating bobbin and a taping unit for taping the wire wound on the bobbin. The turret is provided with a displacement mechanism which moves the spindle between the winding unit and the taping unit, and the winding unit is provided with a change-over mechanism which changes over the wire to be wound on the bobbin.

Preferably, the winding unit and taping unit are disposed on either side of the turret, and the displacement mechanism comprises a rotary actuator which rotates the turret through approximately 180 degrees such that the turret holds the spindle in either a position facing the winding unit or a position facing the taping unit.

Also preferably, the winding unit comprises a nozzle for supplying the wire, a nozzle bar having a fixed nozzle, a clamp provided on the nozzle bar for holding an end of the wire, and a nozzle displacement mechanism for supporting the nozzle bar and moving it in three dimensions.

Also preferably, the wire change-over mechanism comprises a rack for holding a plurality of the nozzle bars, and a displacement arm for transferring the nozzle bar between the rack and the nozzle displacement mechanism.

The details as well as other features and advantages of this invention are set forth in the remainder of the specification and are shown in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic side view of a coil winding device according to this invention.

FIG. **2** is a perspective view of a nozzle bar, taping unit, turret, transfer mechanism and conveyor according to this invention.

FIG. **3** is a perspective view of a taping unit and nozzle bar displacement mechanism according to this invention.

FIG. **4** is a side of the displacement mechanism.

FIG. **5** is a perspective view of the essential parts of the nozzle bar and a wire tying device according to this invention.

FIG. **6** is a perspective view of a displacement mechanism of the wire tying device according to this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. **1** of the drawings, a pair of columns **9** stands on a base **100**, a turret **1** being supported between these columns **9**.

As shown in FIG. **2**, the turret **1** is connected to a rotary actuator **10** fixed on a column **9**, the turret **1** being turned through 180 degrees in the direction of the arrow in FIG. **1** by driving the rotary actuator **10**.

As shown in FIG. **2**, a spindle **2** is attached to the turret **1**. The spindle **2** supports a bobbin **80** used for winding a wire, and is rotated by a motor, not shown, inside the turret **1**.

The bobbin **80** supported by the spindle **2** moves between two positions depending on the rotation position of the turret **1**. In one position, winding is performed by a winding unit **4**, while in the other position, taping is performed by a taping unit **3**.

The taping unit **3** comprises a tape holder **12** and tape guide **13** fixed on a bracket **11** to the upper part of the column **9**, a tape clamp **14** which grips the end of the tape below the holder **12** and guide **13**, a roller **15** which smooths the tape on the bobbin **80**, and a tape cutter **16**.

The tape clamp **14**, roller **15** and tape cutter **16** are fixed to a taping platform **18** supported by a pair of slide rods **17**. As shown in FIGS. **3** and **4**, the slide rods **17** are supported by a sliding base **19** mounted on the base **100** such that the base **19** is free to be moved along axes X, Y and Z by motors **20**, **21** and **22**.

When taping is performed, the end of a tape projecting from the tape holder **12** through the tape guide **13** is gripped by the tape clamp **14**, and the sliding base **19** is moved by the motors **20**, **21** and **22** so as to cause the tape to adhere to the bobbin **80**. After winding the tape onto the outer circumference of the bobbin **80** by rotating the spindle **2** while the tape is smoothed on the bobbin **80** by the roller **15**, the tape is cut by the tape cutter **16**.

The wire winding unit **4** comprises a nozzle bar **23** to which is fixed a nozzle **24**, a wire tying device **36**, a wire end processing device **45** and a wire clamp device **46**. As shown in FIG. **5**, the nozzle **24** is fixed to a nozzle holder **25** projecting at right angles to the nozzle bar **23** such that the nozzle is oriented downwards. Wire is fed from the tip of the nozzle **24**, this wire being supplied to the nozzle at a predetermined tension from tensioners **58** to **60** to be described hereinafter.

The nozzle holder **25** consists of a clamp **26** having a pair of plates **26***a* and **26***b* which grip the end of the wire at its tip.

The nozzle bar **23** is supported on the upper ends of a pair of sliding rods **27** mounted on a sliding base **32** which moves in the X, Y and Z axial directions together with the sliding base **19**. A platform **28** is fixed to the upper ends of the sliding rods **27**, a bar support **30** being supported on the platform **28** such that it can be rotated by a rotary actuator **31**. The two ends of the nozzle bar **23** rest on this bar support **30** such that they can be engaged or disengaged by an air cylinder **29**.

The sliding bases **19** and **32** are moved in the X axis direction by the motor **20**, and the Y axis direction by the motor **21**. Further, as shown in FIG. **4**, the sliding base **19** is supported by a ball race **33**, and the sliding base **32** by a ball race **34**. These ball races **33** and **34** are connected by a belt **35**, the sliding bases **19** and **32** being moved up and down together in the Z direction by driving the belt **35** with the motor **22**. Although the sliding bases **19** and **32** move together, a construction is also possible wherein they move separately.

The wire tying device **36** is provided below the bobbin **80** in its winding position. As shown in FIGS. **5** and **6**, the wire tying device **36** consists of a clamp pin **37** formed together with a semicircular tiepin **38** in a one-piece construction, fixed to the tip of a rod **40** on which is threaded a wire discharge sleeve **39**. A small wedge-shaped gap is formed between the clamp pin **37** and the tip of the rod **40** so as to hold the wire.

The rod **40** is supported by a box **41** on a supporting plate **42**. The box **41** houses an air actuator which moves the rod **40** up or down. The supporting plate **42** is attached to a sliding base **67** inside a holder **66** fixed to the column **9**, this base **67** being moved in the X axis direction by a motor **43** and in the Y axis direction by a motor **44**.

The wire discharge sleeve **39** has the function of removing wire tied to the outer circumference of the tiepin **38**, and is slid up and down over the rod **40** by an actuator, not shown.

The wire end processing device **45** is supported on the base **100**. The wire end processing device **45** is supported and moved in the X, Y, Z axial directions by separate displacement mechanisms, not shown, which are similar to the sliding bases **19** and **32**. The device **45** ties the wire to a first terminal pin fixed to a rim of the bobbin **80** between the nozzle **24** and the tiepin **38**, and then cuts the end of the wire.

The wire clamp device **46**, which is fitted to the sliding base **67**, holds a part of the wire to the outer circumference of the bobbin **80** to make a bent part when winding begins after tying the wire to the first terminal pin of the bobbin **80**, and when the wire is tied after winding to a second terminal pin also fixed to the rim of the bobbin **80**. A tape sticking device **47** is also supported on the column **9** above the bobbin **80** in its winding position in order to fix these bent parts to the outer circumference of the bobbin **80** by means of pieces of tape.

In the aforesaid construction, when winding begins, the wire between the nozzle **24** and the clamp **26** is gripped by the clamp pin **37** and the rod **40**, and wound several times on the tiepin **38**. Next, the end processing device **45** ties the wire between the tiepin **38** and nozzle **24** on the first terminal pin of the bobbin **80**, and cuts the wire on the side of the tiepin **38**. From the first terminal pin of the bobbin **80**, the wire is guided to the outer circumference of the bobbin **80**, the bent part formed by the clamp device **46** is attached to the bobbin **80** by the tape sticking device **47**, and the spindle **2** is rotated as wire is supplied by the nozzle **24** so as to wind the wire on the bobbin **80**.

After winding is finished, a bent part of the wire is again fixed on the outer circumference of the resulting coil by the clamp device **46** and tape sticking device **47**, and the wire is tied to the tiepin **38**. The wire between the bent part and the tiepin **38** is then tied to the second terminal pin of the bobbin **80**, and its end cut on the side of the tiepin **38** by the end processing device **45**.

The end of the wire remaining on the tiepin **38** is removed by the upward movement of the wire discharge sleeve **39**.

A wire change-over mechanism **5** is provided on the base **100** at the rear of the wire winding unit **4**. As shown in FIG. **1**, this change-over mechanism **5** comprises an arm **49** provided with a pair of hooks **48** to grip the nozzle bar **23** which is supported on the platform **28** from the rear, and a rack **50** which carries a plurality of nozzle bars **23**.

The arm **49** is supported horizontally by a column **51** mounted on the base **100**, and is made to elongate or contract in the X axis direction by an air cylinder, not shown.

The rack **50** is provided with a plurality of crosspieces **54** fixed in stepwise fashion on a pair of poles **53**. Nozzle bars **23** which are not in use are held on these crosspieces. The rack **50** is moved up or down in the Z axis direction by a motor, not shown.

Various wires are stored on wire frames **55** to **57**. Tensioners **58** to **60** are provided between the frames **55** to **57** and the rack **50** so as to keep the wires supplied from the frames to the nozzle bars **23** under a predetermined tension.

Change-over of the wire to be wound on the bobbin **80** is performed by the mechanism **5** which changes over the nozzle bars **23**. In such a case, the arm **49** is extended toward the turret **1** through an empty space in the rack **50** so as to grip a nozzle bar **23** supported on the platform **28** by means of the hooks **48**. Next, the air cylinder **29** is released, and after lowering the slide rods **27**, the arm **49** is retracted so as to lay the nozzle bar **23** on a crosspiece of the rack **50**. The hooks **48** are then released, and the arm **49** is further withdrawn. This completes recuperation of the nozzle bar **23**.

Next, the rack **50** is moved up or down in the Z axis direction until a nozzle bar **23** which it is desired to use is at the same height as the arm **49**. The arm **49** is extended to grip this nozzle bar **23** with the hooks **48**, and the arm **49** is further extended so as to carry the bar **23** above the platform **28**. The slide rods **27** are then raised so that the bar **23** is laid on the platform **28**, and the bar is engaged with the platform **28** by the air cylinder **29**.

The change-over of nozzle bars **23** is accomplished in this manner. Moreover, by reversing the position of the turret **1**, taping of the bobbin **80** can be performed while the change-over operation is proceeding.

A transfer mechanism **6** which changes over bobbins is installed on the side of the taping unit **3** opposite to the turret **1**. As shown in FIG. **2**, the transfer mechanism **6** comprises a conveyor **8** provided with pallets **7** which move in the Y direction, and a receiving platform **63** which transfers the bobbin between the turret **1** and pallets **7**.

The receiving platform **63** is fixed to a bracket **61** which moves in the X direction on the base **100**, and it is made to pivot through 180 degrees about an axis **63A** by means of a rotary actuator **62**. Clamps **65** which grip holds **64** formed on the bobbin are provided on both sides of the receiving platform **63**.

The receiving platform **63** grips the holds **64** on a new bobbin **81** carried by the pallets **7** of the conveyor **8** by means of the clamps **65**, and after pivoting, it moves toward the turret **1** so as to load the bobbin **81** on the spindle **2**. Also the holds **64** on a bobbin **80** previously loaded on the spindle **2** are gripped by the clamps **65**, the bobbin **80** is removed from the spindle **2**, and is then transferred to the pallets **7**.

From the aforesaid description, this coil winding device will be seen to possess the following advantages.

The taping unit **3** is in a position different from that of the winding unit **4**, so there is sufficient working space for both units and wire change-over can be performed without obstruction from the taping unit **3**. Wire change-over can thus be automated, and the system can be readily adapted to a variety of different winding operations.

Further, taping and wire change-over are performed simultaneously so that working time is considerably shortened.

By providing the clamp **26** at the tip of the nozzle holder **25**, the end of the wire is gripped in the vicinity of the nozzle **24** by means of a simple construction. The nozzle bar **23** therefore moves together with the end of the wire, and change-over or storage of the nozzle bar is easily performed.

Further, by gripping the wire in the wedge-shaped gap between the clamp pin **37** provided on the tiepin **38** and the rod **40**, the wire can easily be fastened to the tiepin **38**, and the tied wire is prevented from falling off the tiepin **38** when the nozzle **24** moves.

Winding of different types of wire can thus be combined with taping in any desired combination of operations. This is suitable for a coil winding device required to produce small quantities of many different products.

In the aforesaid example, the turret **1** rotates to move the spindle **2**, but such a construction is also possible wherein the turret **1** moves forwards, backwards or laterally so as to move the spindle **2** between the winding unit **4** and taping unit **3**.

The foregoing description of the preferred embodiments for the purpose of illustrating this invention is not to be considered as limiting or restricting the invention, since many modifications may be made by those skilled in the art without departing from the scope of the invention.

What is claimed is:

1. A coil winding device comprising:

a turret having spindle means for rotating a bobbin;

winding unit means, positioned adjacent the turret, for winding a wire on the rotating bobbin, said winding unit means being provided with change-over means for changing over the wire to be wound on the bobbin;

said winding unit means comprising a nozzle bar, nozzle means provided on said nozzle bar for supplying the wire, clamp means provided on said nozzle bar for holding an end of the wire, and nozzle displacement means for supporting the nozzle bar and moving it in three dimensions;

taping unit means, positioned adjacent the turret, for taping the wire wound on the bobbin;

said turret being provided with displacement means for moving said spindle means between the winding unit means and the taping unit means;

said winding unit means and taping unit means being disposed on either side of said turret;

said displacement means comprising rotary actuator means for rotating the turret through approximately 180 degrees such that the turret holds the spindle means in either a position facing the winding unit means or a position facing the taping unit means.

2. A coil winding device as defined in claim **1**, wherein the change-over means comprises:

rack means for holding a plurality of said nozzle bars, and

displacement arm means for selectively transferring each said nozzle bar between the rack means and the nozzle displacement means.

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